DISCOVERY OF RAPID OSCILLATIONS IN Ap STAR HD 99563

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ABSTRACT. The observations of roAp stars at the Mt. Dushak-Erekdag station of Odessa Astronomical Observatory (Central Asia) have been carried out since 1992. In 1994 the searches for a new roAp stars were initiated. There were investigated 5 stars - candidates: HD15257, HD17317, HD99563, HD115606, HD217401. Their photometric features are presented. The Fourier spectra of 4 stars did not show variability in the high frequency region. The Fourier spectrum of HD99563 revealed the oscillations with a period of about 11.2 min. and amplitude 3.98 mmag. Evidently HD99563 is a new discovered roAp star.

Key words: Stars: Chemically peculiar - stars: Oscillations - stars: Variables: other

Rapidly oscillating Ap stars discovered by Don Kurtz in 1978 (Kurtz,1990), are remarkable by low-amplitudes pulsations with periods from 5 to 20 min. These peculiar stars with line strength anomalies of Sr, Cr, Eu (may be one or two of these elements) possess strong magnetic fields. The objects are very important for asteroseismology: some of them have a rich set of pulsations, other pulsate with a single frequency.

Nearly all of 28 investigated up to now roAp stars were discovered in SAAO, by the Kurtz and Martinez group (see Kurtz, 1990; Martinez et al., 1993; Martinez & Kurtz, 1994a, 1994b). Although about 200 stars were examined for discovering especially northern roAp stars: Mattews & Wehlau (1985), Heller & Kramer (1988), Nelson & Kreidl (1993) - only two stars with positive declination are known. The most part of the objects is in southern hemisphere.

The search for the new roAp stars in the northern hemisphere is very important. Firstly, a number of southern and nothern roAp stars should be balanced. Secondly, it is necessary to extend the sample for more accurate definition of its astrophysical features. Thirdly, null results extend the sample of noAp (non-oscillating) stars, that is essential for the understanding of evolutionary processes, which distinguish oscillating Ap stars from the reliable stable Ap stars (see, for example, Mathys et al.,1996)

The test observations of well-studied HR1217 (HD24712) (Dorokhov et al., 1994b) showed that sky seeing of the Mt. Dushak-Erekdag is suitable for roAp star researches. The successful participation in the multisite γ Equ campaign 1992 organised by T.Krejdl and M.Nelson jointly with European Southern, Lowell, South African and Perth Observatories (Martinez et al., 1996) encouraged us to continue the roAp observations.

Since 1994 we started a survey for rapidly oscillating Ap stars at the Mt. Dushak-Erekdag observational station. Martinez, Kurtz and Kauffmann (1991) presented the detail searching scheme. They worked out the photometrical indicator for roAp stars based on the Strömgren colours. The method turned out to be very fruitful: approximately one from ten investigated stars was discovered as roAp star (Martinez & Kurtz, 1994). These photometrical criteria were used for extracting the list of candidates from uvby,beta Catalogue (Hauck & Mermilliod, 1990) the obtained list was verified with Catalogue Ap and Am stars (Renson, 1991) and the stars with SrCrEu peculiarities were saved. When remained numbers of stars were verified with the records of roAp and noAp stars by Martinez & Kurtz (1994), we re-

Table 1.

Star	b-y	m_1	c_1	β	$\alpha(1900)$	$\delta(1900)$	m_v	Sp	Sp (Rn)
HD15257	+0.178	+0.211	+0.780	2.762	2 22.3	+29 14	5.38	F0	
HD17317	+0.230	+0.226	+0.779	2.750	2 41.7	+20 56	8.3	A5p	
HD99563	+0.171	+0.206	+0.745	2.830	11 22.2	- 8 19	8.17	F0	F0 Sr
HD115606	+0.166	+0.297	+0.623	2.841	13 13.1	+13 31	8.3	A2	A2 Sr
HD217401	+0.187	+0.264	+0.717	2.737	22 55.3	+13 29	8.0	A2p	A2 Sr

vealed that approximately 30% of our candidates were presented in there. That is we picked the right way.

The observations were episodic, because the Mt.Dushak-Erekdag station is located in 3 thousands kilometers from Odessa, and we visited the station for participation in international programs or multisite campaigns. During 4 years we were able to observe 5 stars of the candidates' list. All the observations were carried out with the dual-channel photometer (Dorokhov & Dorokhova, 1994) mounted on 0.8 m Ritchey-Chretien telescope.

SPE package by Sergeev (1992) was adapted for a data reducing and filtering. We used a rectangle filter for the data smoothing and low-frequency Butterworth's filter for excluding trends.

The programs PERIOD by Breger (1990) and FOUR by Andronov (1994) were used for the frequency analysis.

Comparison star in the second channel of the photometer was observed if the suitable star occurred in the field of view. Even if the data of comparison star were not directly used for the light curve of investigated star (large differencies of magnitudes or of spectral types), the second channel data were adapted for estimate of the sky transparency behavior in the high frequency region.

Table 1 lists HD numbers, Strömgren indices, positions (epoch 1900.0), magnitudes, spectral types from HD Catalogue and spectral types from Catalogue by Renson (1991) for all observed stars.

Table 2 is a Journal of observations: HD number, date, were used or no comparison star data, observational interval in hour, mean deviation for high-frequency region of the research star in mmag, the filter. The Fourier spectra of 4 stars which did not show the variability in the frequency region 50 - 400 c/d are presented in Fig 1 and 2.

The HD number of the star is shown above the panel and the Julian Date, the duration of the observations (in hours) and the number of 20-s integrations are listed in the upper right corner of the panel (following to Martinez & Kurtz, 1994b).

HD 17317 with comparison star were observed only 1.1 h on a poor photometrical night and the noise level was up to 12 mmag. After normalizing by the comparison star data the noise level decreased to 5 mmag and the absence of high frequency oscillations in this star is rather plausible (Fig.2). A low-frequency component of the data was filtered by Butterworth's filter (2 degree and 8% cutoff frequency).

HD 99563 was observed on the night 12/13 May of 1997 during 2 hour.
The data were acquired as continuous 10 sec integrations, the comparison star ($\alpha(1900)=11^h22^m50^s$, $\delta(1900)$= -08°28′.5) was observed simultaneously in channel 2. Low-frequency trends of the data were removed with using Butterworth's filter (2 degree and 4% cutoff frequency). Fourier spectrum of

Table 2.

Star	Date	C	ΔT	σ	Flt
HD15257	22.11.1995		6.0	0.9	B
HD17317	01.11.1995	c	1.1	6.5	B
HD99563D	12.05.1997	c	2.0	1.6	B
HD115606	13.04.1997		4.0	1.1	B
HD217401D	13.09.1994	c	3.8	1.4	v Str
	10.10.1994	c	3.4	1.2	v Str

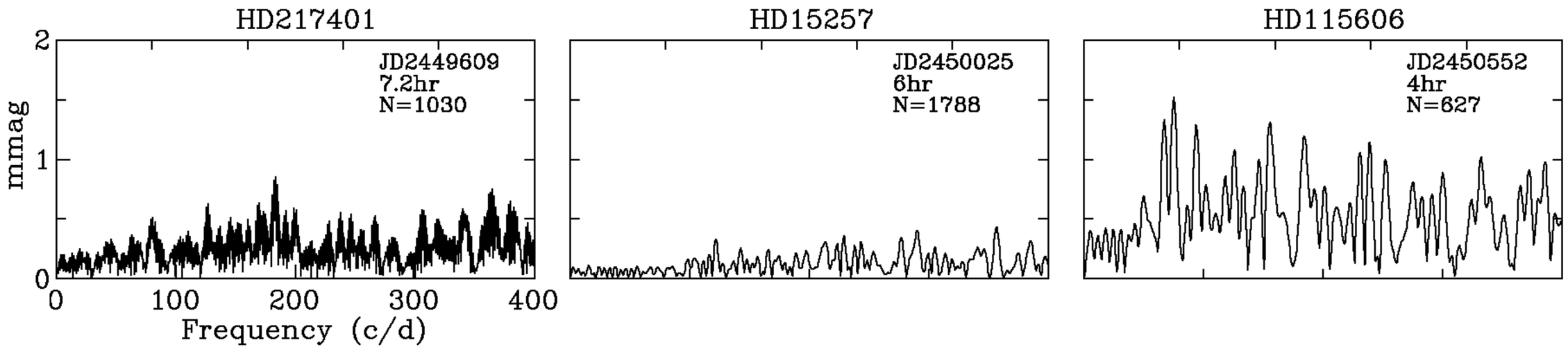


Figure 1: The null result of searches for high-frequency pulsation in Ap stars. Fourier spectra of 3 stars.

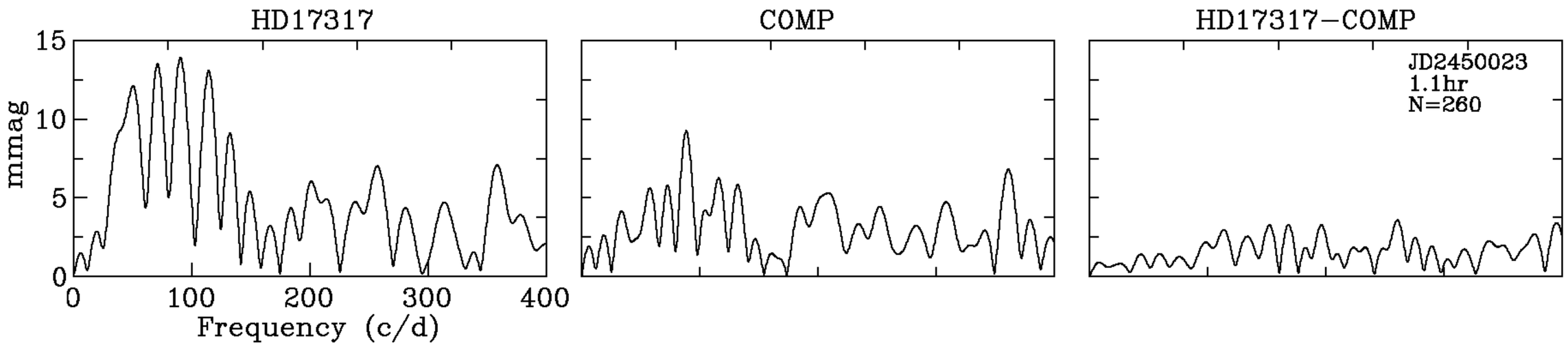
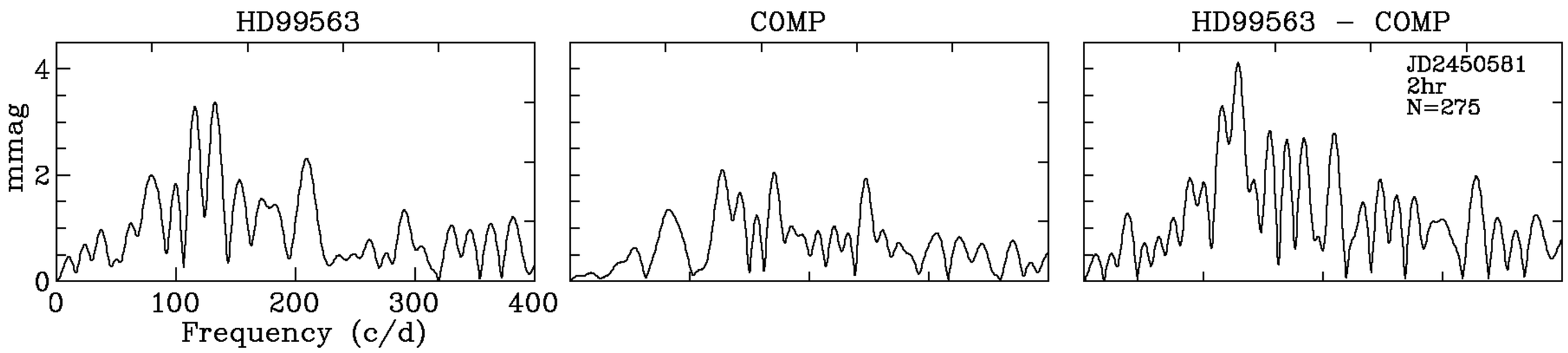


Figure 2: Fourier spectra of HD17317 (left) and comparison star (center) in the poor photometrical night. On the right panel - Fourier spectrum of differencies



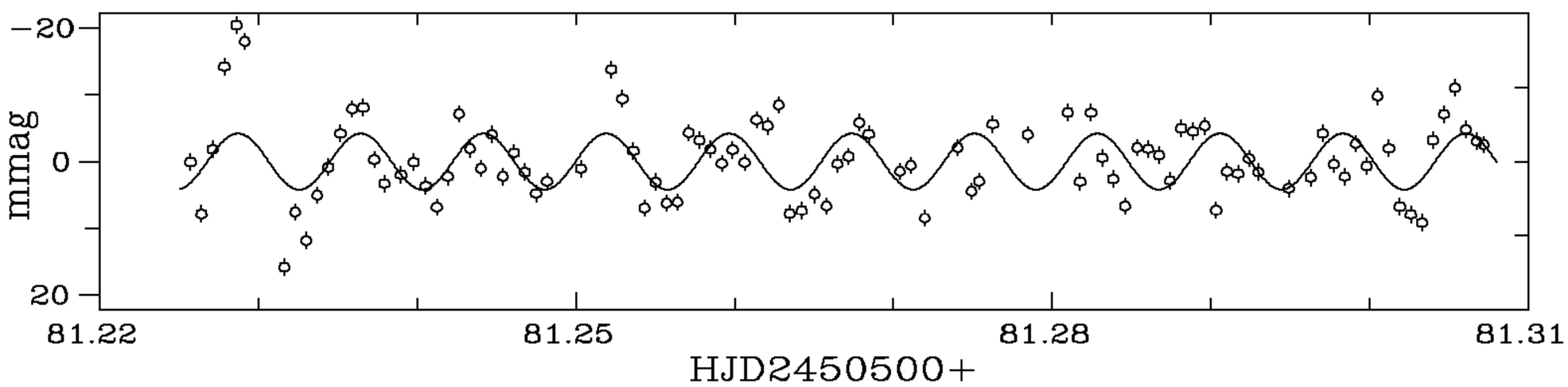


Figure 3: (Top) Fourier spectra of HD99563 (left), comparison star (center) and Fourier spectrum of differencies (right panel). (Bottom) The light curve of HD99563 with the best-fit sinusoid of the period 11.2 min.

HD99563 revealed the peak at the frequency 127.6 c/d (top left panel in Fig.3). Normalizing by the comparison star data yielded the more prominent peak (top right panel in Fig.3) at frequency f=128.9±0.635 c/d (period 11.2 min and semi-amplitude 3.978±0.38 mmag).

A bottom panel in Fig.3 shows 2 hour's light curve of the star with the best-fit sinusoid of the period 11.2 min.

Evidently a new roAp star is discovered, but the results of the work may be considered only as preliminary. We share the cautions made by Martinez & Kurtz (1994b), that roAp stars must be observed under the best atmospheric conditions and the observations have to be continued until the repeated reliable results are achieved. However this work was done without any financial support, "thanks to enthusiasm", and we had to use the "scraps" of observational time which was unworkable for base program stars.

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References:

Andronov I.L.: 1994, *Odessa Astronomical Publications*, **7**, 49

Breger M.: 1989, *Commun. Asteroseismology*, **6**

Dorokhov N.I., Dorokhova T.N., Komarov N.S., Mukhamednazarov S.: 1994a, *Odessa Astronomical Publications*, **8**, 167

Dorokhov N.I., Dorokhova T.N.: 1994b, *Ibid*, **8**, 168

Dorokhov N.I., Dorokhova T.N., Mkrtichian D.E.: 1994c, *Ibid*, **8**, 169

Hauck B., Mermilliod M.: 1990, *Astron. and Astrophis. Suppl.*, **86**, 107

Heller C.H., Kramer K.S.: 1988, PASP, 100, 583

Kurtz D.W.: 1990, *Ann. Rev. Astron. Astrophys.*, **28**, 607

Martinez P., Kurtz D.W., Kauffmann G.M.: 1991, *MNRAS,* **250,** 666

Martinez P., Kurtz D.W.: 1994a, *MNRAS*, **271**, 118

Martinez P., Kurtz D.W.: 1994b, *MNRAS*, **271**, 129

Mathys G., Kharchenko N., Habrig S.: 1996, *Astron. and Astrophis.*, **311**, 901

Matthews J.M., Wehlau W.H.: 1985, *PASP*, **97**, 841

Nelson M.J., Kreidl T.J.: 1993, *AJ*, **105**, 1903

Renson P.: 1991, *General Catalogue of Ap and Am stars*, Liege University

Sergeev S.G.: 1992, private communication